The ecosystem approach to fisheries management in CCAMLR

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Abstract

The ecosystem approach to fisheries is part of a wider framework of marine ecosystem-based management, or EBM. EBM is dedicated to managing the environment in a sustainable way, taking into consideration societal and ecological objectives, as well as the economic. It is an integrated approach, based on the principles of sustainable development, with international recognition and guidance.

In the Southern Ocean, fisheries management is undertaken through the Commission for the Conservation of Antarctic Marine Living Resources, otherwise known as CCAMLR. The aim of this research is to analyse the implementation and effectiveness of EBM and the ecosystem approach to fisheries in CCAMLR, using a qualitative approach comprising of a literature review, document analysis, and comparison with two case studies in the South East Atlantic and South Pacific Ocean.

Although CCAMLR has made significant progress recently in terms of spatial management as part of an ecosystem approach to fisheries, more work is needed for CCAMLR to develop an integrated approach to ecosystem-based management in the Southern Ocean.

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Contents

1. Introduction

Fishing and conservation are two activities that seem to exist at opposite ends of the same spectrum. One is concerned with the extraction of resources, and the other with the protection of the environment. They have different aims and objectives, and by all rights, should not intersect. Marine fisheries have a long history of exploitation, and traditional fisheries management approaches do not necessarily consider species other than those targeted by harvesting. But there is a growing movement towards a different approach, one that considers the impacts of fishing on the environment, and the sustainability of the resources being harvested.

An ecosystem approach to fisheries (EAF) promotes the sustainable use of resources in the marine environment by integrating fisheries management with ecosystem management (Garcia et al., 2003). Essentially, the EAF builds on traditional single-species management by broadening the context to encompass entire ecosystems. Ecosystem management is an area-based strategy with the aim of maintaining ecosystems in a sustainable condition in order to achieve the desired benefits (Garcia et al., 2003). The integration of ecological, social, economic, and governance considerations is key to the EAF, with humans an integral component in the system (Fletcher & Bianchi, 2014; Marasco et al., 2007). Key commonalities of an EAF are taking a 'whole-ocean' view and involve mitigating the effects of fishing and restoring marine ecosystems (Short, Graham, & Grieve, 2008).

The EAF is part of a wider framework of ecosystem-based management, also known as EBM. The idea behind EBM is to manage the human activities that impact on ecosystems through management decisions that take the effects of such activities into account (Long, Charles, & Stephenson, 2015). Defining characteristics of EBM include collaboration, stakeholder participation, application of the precautionary approach to deal with uncertainty, and adaptive management to feed new information back into management decisions as it emerges (Curtin & Prellezo, 2010).

Unlike the EAF, EBM is multi-sectoral. This is a key distinction, only lightly touched on in discussions of EBM (McLeod et al., 2005; Short et al., 2008). A sector is an interest group that is affected by management decisions (Murawski, 2007). Marine sectors include the fishing industry, the oil and gas industries, recreational users of marine space, shipping and transport, coastal development, and the tourism industry (Curtin & Prellezo, 2010). The EAF considers fishing within a wider context, but essentially remains within the fisheries sector. However, an EBM approach considers multiple impacts on the environment, across different sectors (Katsanevakis et al., 2011). EBM is a way of managing a

wide range of human activities traditionally addressed within separate sectors, or 'silos' (Long et al., 2015). Moving beyond a compartmentalized approach to resource management is crucial for the management of cumulative impacts such as pollution, habitat degradation, climate change, and eutrophication (Curtin & Prellezo, 2010). Cumulative impacts are those that are typically greater than the sum of individual impacts due to multiplicative or interactive effects, and therefore cannot be managed in isolation (Halpern et al., 2008). In terms of EBM, the interdependency of all components in the system is an important caveat to consider (Katsanevakis et al., 2011). The ecosystem approach of a fisheries sector can prepare for integration with other sectors, but at a conceptual level it cannot fully implement EBM without an integrative, overarching arrangement (Short et al., 2008).

1.1 CCAMLR

Implementing an ecosystem approach to fisheries management in the Southern Ocean is the responsibility of the Commission for the Conservation of Antarctic Marine Living Resources, otherwise known as CCAMLR. Key elements of the CCAMLR ecosystem approach to fisheries management include application of the precautionary approach, environmental protection, and consideration of the effects of fishing on non-target species (Miller & Slicer, 2014).

The Convention for the Conservation of Antarctic Marine Living Resources, hereafter referred to as the CAMLR Convention, was adopted in 1980 and came into force in 1982, and is widely recognized as being a precursor to the EAF (Garcia et al., 2003). CCAMLR falls under the umbrella of the Antarctic Treaty System (ATS). The Antarctic Treaty was signed in 1959, came into force in 1961, and comprises the entire area south of 60˚ Southern Latitude. Under the ATS, CCAMLR manages all fishing activity south of the Antarctic Convergence (Figure 1), except for the sub-Antarctic islands where sovereign states retain jurisdiction (Kock, 2000).

The CCAMLR Convention area is split up into three sectors which correspond to statistical areas in the Atlantic Ocean (area 48), the Indian Ocean (area 58), and the Pacific Ocean (area 88). Statistical areas are then divided into subareas and divisions, and are named after the Food and Agriculture Organisation of the United Nations (FAO) statistical fishery regions (Croxall & Nicol, 2004; Kock, 2000). The Commission is the decision-making body of the Convention, and oversees the creation of conservation measures to regulate activity in the Convention area. Conservation measures are binding to all members of CCAMLR, whereas Resolutions are non-binding. Catch limits, for example, are defined in conservation measures that specify the species to be harvested and the location, duration, and extent of fishing within a given season.

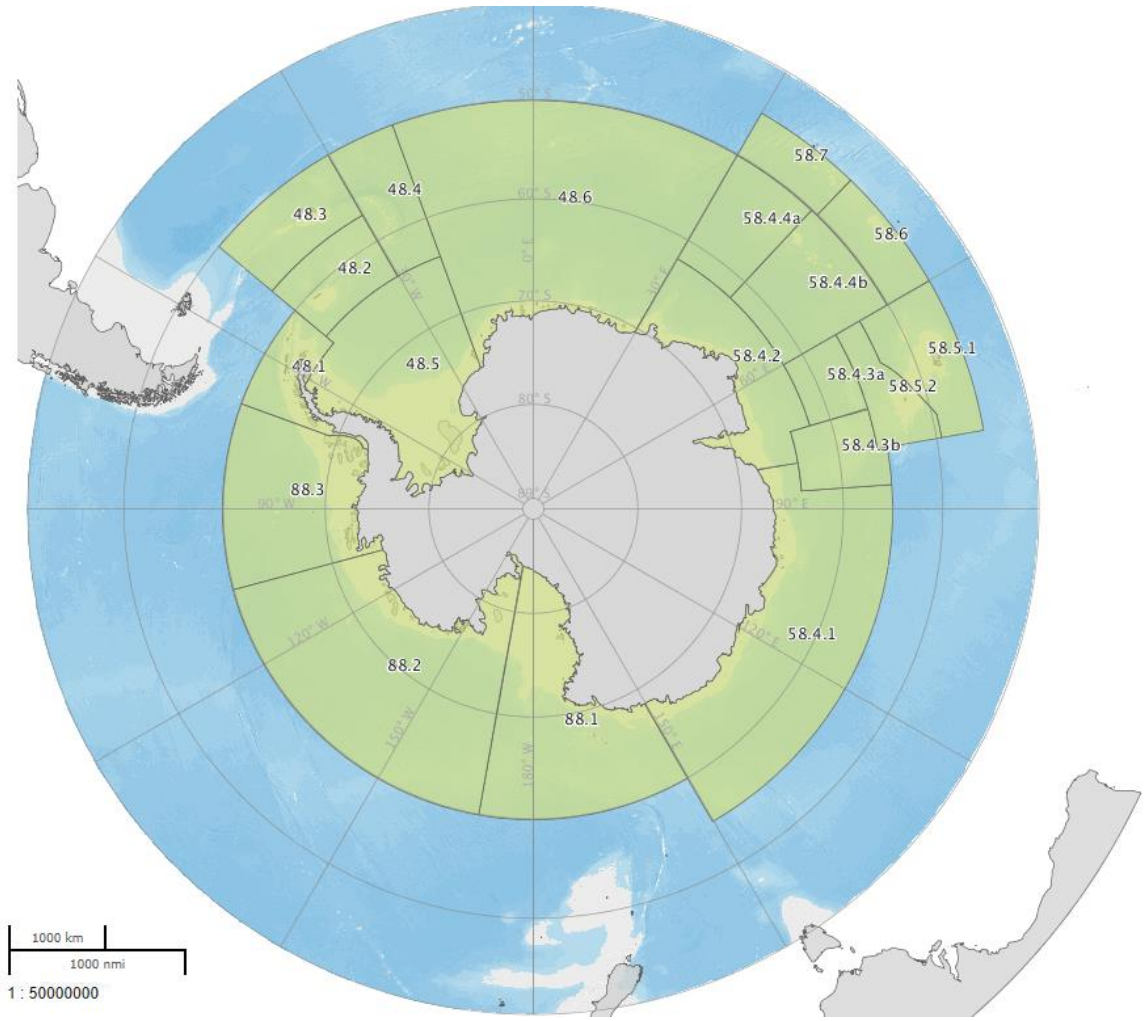

Figure 1. Convention area of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR).

Target species for fisheries in the Convention area are the Patagonian toothfish (*Dissostichus eleginoides*) and Antarctic toothfish (*Dissostichus mawsoni*), as well as Antarctic krill (*Euphausia superba*), and to a lesser extent, mackerel icefish (*Champsocephalus gunnari*).

The Scientific Committee provides management advice to the Commission based on the assessments of its two working groups. The Working Group on Ecosystem Monitoring and Management (WG-EMM) is for the krill fishery and the CCAMLR Ecosystem Monitoring Program (CEMP), while the Working Group on Fish Stock Assessment (WG-FSA) is for fish stock assessments and bycatch of the fisheries (Kock, 2000). The CEMP was established in 1987, and monitors changes in selected prey species, dependent

predator species, and environmental indicators (Agnew, 1997). The aims of the CEMP are to detect changes in components of the marine ecosystem, and to distinguish between changes due to environmental variability and changes due to harvesting as part of an ecosystem approach to fisheries (CCAMLR, 2013).

Environmental protection in the Southern Ocean is not just covered by CCAMLR. As the Southern Ocean is part of the Antarctic Treaty area, measures and agreements adopted by the Antarctic Treaty Consultative Parties (ATCPs) also come into play. The ATCPs adopted Agreed Measures on the Conservation of Antarctic Flora and Fauna in 1964, which includes regulations on Specially Protected Areas, and in 1991 adopted the Protocol on Environmental Protection to the Antarctic Treaty (ATS, 2011).

The Protocol on Environmental Protection, hereafter referred to simply as the Protocol, came into force in 1998. It designates Antarctica as a natural reserve devoted to peace and science, and establishes a framework for environmental protection including the prohibition of activities relating to mineral extraction other than for scientific research. The Protocol provides a comprehensive approach to environmental management, as opposed to a series of ad hoc resolutions from the Antarctic Treaty Consultative Meetings (ATCM). The Committee for Environmental Protection (CEP) was established to provide advice to the ATCM on implementing the Protocol, and meets annually alongside the ATCM (Sánchez & McIvor, 2007). The Protocol has six annexes that cover a broad range of issues, including environmental impact assessment, conservation of Antarctic fauna and flora, waste disposal and waste management, prevention of marine pollution, management of protected areas, and liability for environmental emergencies. A five-year rolling work plan is developed to prioritise issues and to guide the work of the CEP, allowing the Committee to anticipate future challenges. Key priorities of the 2015 work plan are to address the risks associated with the transfer of non-native species into Antarctica, manage the environmental impacts of the tourism sector, understand the environmental consequences of climate change in Antarctica, and improve the effectiveness of management and further develop area protection in Antarctica and the Southern Ocean (CEP, 2016).

The CAMLR Convention applies to all populations of Antarctic marine living resources except those already covered by other pre-existing agreements. Several international agreements negotiated outside the ATS are relevant to activity within the area of the Antarctic Treaty, and the work of CCAMLR to conserve Antarctic marine living resources. The Convention on Biological Diversity (CBD) came into force in 1993, and is concerned with the conservation of biological diversity, the sustainable use of

components of biological diversity, and the equitable sharing of benefits of genetic resources. The CBD offers guidance for decision-makers on the application of the precautionary principle to protect biological diversity in circumstances of uncertainty, and promotes the use of the ecosystem approach as a framework for action (United Nations Secretariat of the Convention on Biological Diversity, 2000). The United Nations Convention on the Law of the Sea (UNCLOS) is a comprehensive regime that sets out rules and regulations for governing the use of the ocean and its resources, and delineates ocean space using jurisdictional boundaries known as exclusive economic zones, or EEZs. UNCLOS opened for signatures in 1982 and came into force in 1994, and is a major regulatory agreement relevant to CCAMLR. Specifically, CCAMLR and UNCLOS intersect through the implementing agreement to UNCLOS of the 1995 United Nations Fish Stocks Agreement (Stephens, 2017).

The Fish Stocks Agreement implements the provisions of UNCLOS regarding the conservation and management of Straddling Fish Stocks and Highly Migratory Fish Stocks. It is based on the precautionary approach, taking best available scientific information into account (United Nations Office of Legal Affairs, 2013). The key objective of the Fish Stocks Agreement is the promotion of ecologically sustainable fisheries within exclusive economic zones and beyond. CCAMLR manages fishing activity in the high seas, and the Fish Stocks Agreement seeks to improve management in this area to address inadequate fishing practices. Regional fisheries management organisations (RFMOs) are responsible under the Fish Stocks Agreement for facilitating cooperation between states fishing in the high seas and within EEZs to manage and conserve fish stocks that travel between jurisdictional boundaries (UN Division for Ocean Affairs and the Law of the Sea, 2010). This cooperation is crucial to managing activity in the high seas as part of an EAF, and therefore highly relevant to CCAMLR's decision-making and conservation objectives in the Southern Ocean.

Although UNCLOS and the Fish Stocks Agreement are important to the management of fishery resources consistent with international practices and guidance, perhaps the most important regulatory relationship of all is between CCAMLR and the Antarctic Treaty System itself. This relationship distinguishes CCAMLR as a conservation organisation, rather than a RFMO (CCAMLR, 2015). Linkages between the principles of conservation embedded within the CAMLR Convention, the ATS, and the Protocol on Environmental Protection place CCAMLR in a unique position in terms of environmental management. There are clear provisions within the CAMLR Convention that bind Contracting Parties to the obligations of environmental protection of the ATS, beyond the requirements of an RFMO or fisheries organisation (CCAMLR, 2015). The relationship of CCAMLR to the Protocol provides an

opportunity for practical implementation of EBM in the Southern Ocean. The Protocol considers impacts across different sectors, essentially allowing CCAMLR to manage fisheries in light of activities that have the potential to impact on marine ecosystems but are beyond its scope (Fabra & Gascón, 2008). This integration is crucial to developing a more responsive and fully realised EBM approach.

1.2 Rationale

Fisheries management organisations are broadening their focus to include the wider ecosystem and not just target species, moving towards more integrated approaches to managing human activities that impact on ecosystems (Willock & Lack, 2006). However, ecosystem-based fisheries management (EBFM) and the EAF are sectoral in nature, whereas at a conceptual level, EBM is not. If the EAF can be seen as an evolution from traditional single-species fisheries management (Barange et al., 2010), then EBM is the next step in the evolutionary ladder. An ecosystem approach can be implemented at multiple levels, broadly encompassing the suite of approaches with an ecosystem focus, moving from levels where the focus is solely on fish stocks with varying degrees of ecosystem considerations, to a level which includes multiple sectoral impacts on ecosystems (Link & Browman, 2014). With a fully realised EBM approach, social, cultural, and political perspectives are overlaid on top of place-based management, allowing for a better understanding of the cumulative impacts of fisheries and other impacts on the marine environment across different sectors (Crowder et al., 2008; Link & Browman, 2014).

The transition from EAF to EBM is a core focus of my research, and rationale. In an era of biodiversity loss and increasing anthropogenic pressure on marine ecosystems, an integrated approach is one way of working towards the goal of sustainable environmental management (Holt et al., 2012). CCAMLR has a well-developed EAF, but to what extent does it implement an integrated EBM approach? How is EBM interpreted in its mandate, and in regulatory measures? And is CCAMLR effective in meeting its EBM conservation objectives and responsibilities?

Ultimately, I am interested in the placement of CCAMLR along a spectrum of EBM. As a conservation organisation with a strong ecosystem focus, and a history of leadership in regard to the EAF, CCAMLR could potentially lead the way in terms of implementing an EBM approach that is integrated, proactive, and sustainable.

1.3 Research aims

The aim of my research is to examine the implementation of EBM in CCAMLR. Specifically, what elements of EBM are present in the CCAMLR EAF? And where does CCAMLR have room to improve? I will undertake a critical analysis of documents such as meeting reports and convention texts, comparing CCAMLR with two case studies near the Southern Ocean – the South Pacific RFMO and the South East Atlantic Fisheries Organisation. CCAMLR is not an RFMO, but has much in common with fisheries management organisations. Both CCAMLR and RFMOs implement measures of EBM such as bycatch mitigation and area protection, and they have a general responsibility to promote sustainable fisheries through EBM and the precautionary approach. By comparing CCAMLR with my two case studies, I hope to get a better contextual understanding of EBM and the EAF in the Southern Ocean.

My primary research question is:

To what extent is ecosystem-based management implemented in CCAMLR?

The following sub-questions are also addressed:

1. How is EBM defined, and what are the components?
2. Are there different levels of implementation?
3. What are the challenges of implementing EBM now and in the future?

The document analysis will be supported by literature on EBM and the EAF, to ground findings with regards to relevant research.

1.4 Outline

The methods used in the research are outlined in chapter two. This is followed by a literature review in chapter three, touching on key concepts and best practice. The results of the document analysis are combined with the discussion and split into three sections on precautionary management and the EAF, spatial management, and then integrated, resilient, and strategic management. Finally, conclusions of the research and emerging themes are presented in chapter seven.

2. Methods

In this chapter, I outline the methods used for my research. I employed a semi-qualitative research approach with a document analysis and literature review to address my research questions. Qualitative data analysis seeks to increase the understanding of a phenomenon by analysing the relationship between data categories or themes (Hilal & Alabri, 2013). In this case, the phenomenon I was seeking to understand is the implementation of EBM in three different organisations.

2.1 Case studies

The case studies used in the document analysis were chosen based on comparability and proximity to CCAMLR. The convention areas of the South East Atlantic fisheries organisation (Figure 2) and the South Pacific RFMO (Figure 3) both have southern boundaries that border the Southern Ocean, and are relatively open, and not closed in by land.

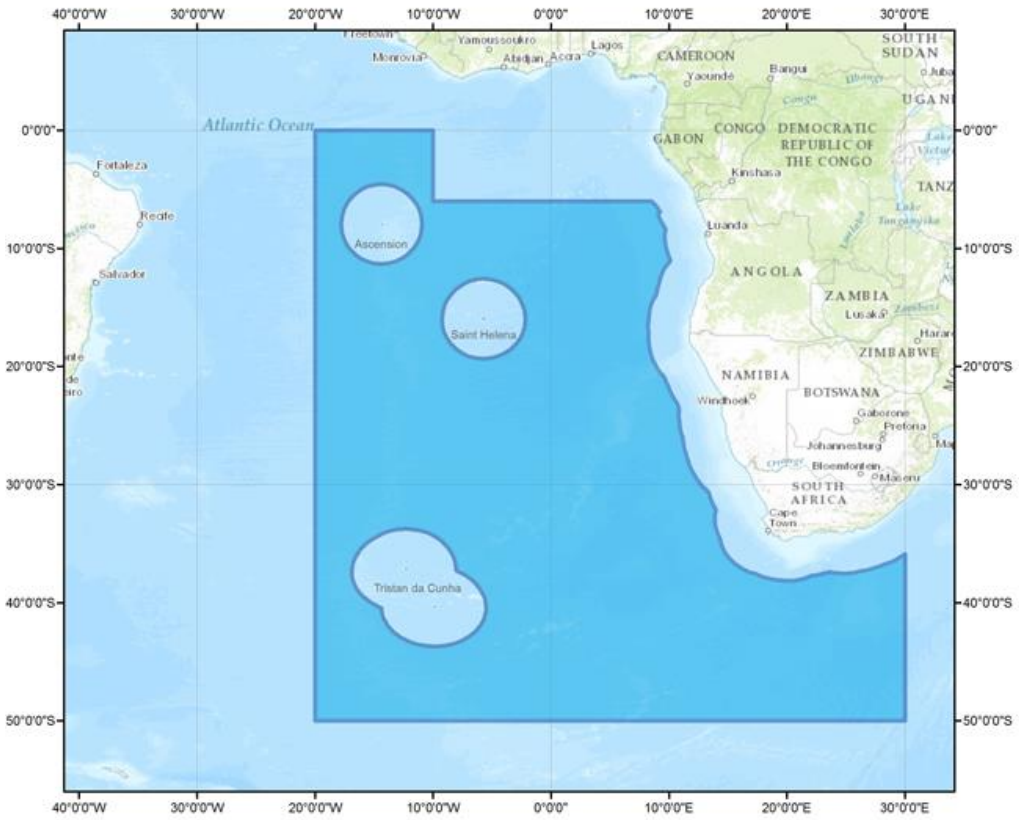

Figure 2. Convention area of the South East Atlantic Fisheries Organisation (SEAFO)

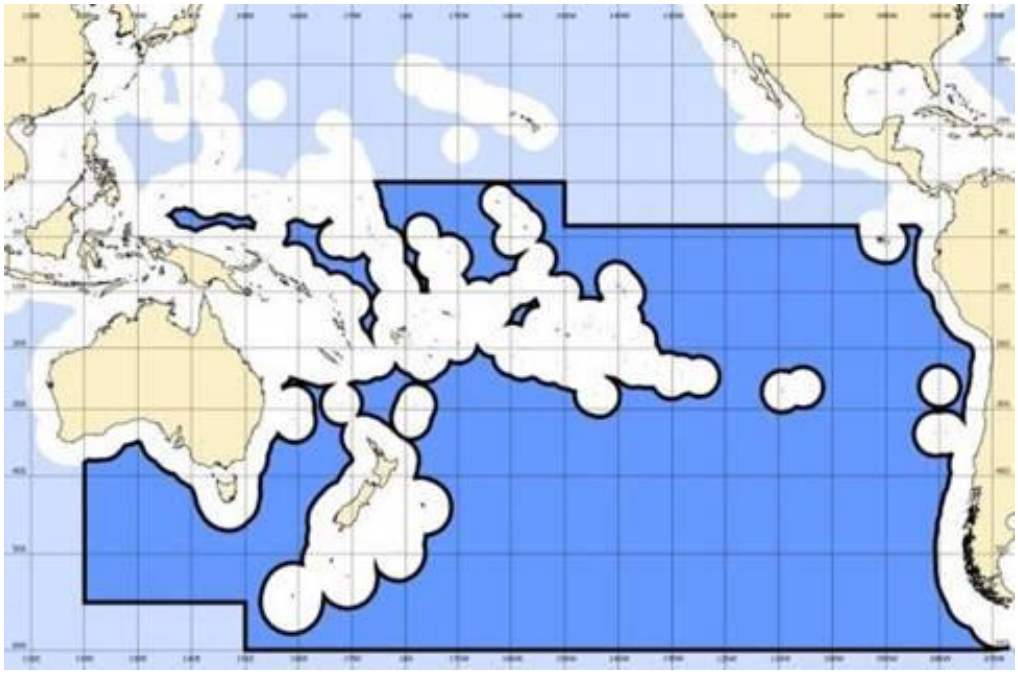

Figure 3. Convention area of the South Pacific Regional Fisheries Management Organisation (SPRFMO).

The South Pacific case study provides an example of a recently established RFMO, as the Convention came into force in 2009. The South East Atlantic case study is an example of a fisheries organisation which is slightly more established, with the Convention entering into force in 2003. Both case studies were negotiated after the adoption of the United Nations Fish Stock Agreement, and thus provide a basis for comparison of RFMO's developed within a much different policy environment than that of the 1982 CAMLR Convention.

2.2 Document analysis

A document analysis uses codes or categories assigned to words, sentences, and paragraphs to organise and structure data (Hilal & Alabri, 2013). Categories are then combined to make it easier to look for patterns and relationships within the documents. A document analysis employs elements of content and thematic analysis (Bowen, 2009). Content analysis, or inductive analysis, organises information into categories, whereas thematic analysis, or deductive analysis, looks at patterns within the data and uses emerging themes as categories (Bowen, 2009; Elo & Helvi, 2007). I used a combination of both approaches in the initial stages of the document analysis, and an inductive content analysis throughout the later stages.

Table 1. Documents sourced for case study analysis of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), with a total of 33 documents separated into four different categories.

Category	Document name	About	Pages
General	CCAMLR Convention	Text of the Convention on the Conservation of Marine Living Resources	23
General	Krill fishery report 2015	Krill fishery report 2015	35
CM	CCAMLR CM 26-01	General environmental protection during fishing	2
CM	CCAMLR CM 32-18	Conservation of sharks	1
CM	CCAMLR CM 91-01	Procedure for according protection to CEMP sites	5
CM	CCAMLR CM 91-02	Protection of the values of Antarctic specially managed and protected areas	2
CM	CCAMLR CM 91-03	Protection of the South Orkney Islands southern shelf	2
CM	CCAMLR CM 91-04	General framework for the establishment of CCAMLR marine protected areas	4
CM	CCAMLR r30	Climate change	2
CM	CCAMLR r31	Best available science	2
Meeting	CCAMLR 2005	Report of the 24th Meeting of the Commission	179
Meeting	CCAMLR 2006	Report of the 25th Meeting of the Commission	232
Meeting	CCAMLR 2007	Report of the 26th Meeting of the Commission	210
Meeting	CCAMLR 2008	Report of the 27th Meeting of the Commission	201
Meeting	CCAMLR 2009	Report of the 28th Meeting of the Commission	201
Meeting	CCAMLR 2010	Report of the 29th Meeting of the Commission	175
Meeting	CCAMLR 2011	Report of the 30th Meeting of the Commission	190
Meeting	CCAMLR 2012	Report of the 31st Meeting of the Commission	159
Meeting	CCAMLR SM 2013	Report of the Second Special Meeting of the Commission	73
Meeting	CCAMLR 2013	Report of the 32nd Meeting of the Commission	193
Meeting	CCAMLR 2014	Report of the 33rd Meeting of the Commission	261
Meeting	CCAMLR 2015	Report of the 34th Meeting of the Commission	215
Scientific	CCAMLR SC 2005	Report of the 24th Meeting of the Scientific Committee	663
Scientific	CCAMLR SC 2006	Report of the 25th Meeting of the Scientific Committee	515
Scientific	CCAMLR SC 2007	Report of the 26th Meeting of the Scientific Committee	688
Scientific	CCAMLR SC 2008	Report of the 27th Meeting of the Scientific Committee	749
Scientific	CCAMLR SC 2009	Report of the 28th Meeting of the Scientific Committee	584
Scientific	CCAMLR SC 2010	Report of the 29th Meeting of the Scientific Committee	426
Scientific	CCAMLR SC 2011	Report of the 30th Meeting of the Scientific Committee	460
Scientific	CCAMLR SC 2012	Report of the 31st Meeting of the Scientific Committee	406
Scientific	CCAMLR SC 2013	Report of the 32nd Meeting of the Scientific Committee	342
Scientific	CCAMLR SC 2014	Report of the 33rd Meeting of the Scientific Committee	397
Scientific	CCAMLR SC 2015	Report of the 34th Meeting of the Scientific Committee	423

Table 2. Documents sourced for case study analysis of the South East Atlantic Fisheries Organisation (SEAFO), with a total of 29 documents separated into four different categories.

Category	Name	About	Pages
General	SEAFO Convention	The Convention: South East Atlantic Fisheries Organization (SEAFO)	31
CM	CM04-06	The conservation of sharks caught in association with fisheries managed by SEAFO	2
CM	CM14-09	To reduce sea turtle mortality in SEAFO fishing operations	4
CM	CM25-12	On reducing incidental by-catch of seabirds in the SEAFO convention area	9
CM	CM30-15	On bottom fishing activities and vulnerable marine ecosystems in the SEAFO convention area	18
CM	CM31-15	On total allowable catches and relation conditions for Patagonian Toothfish, Deep-Sea Red Crab, Alfonsino, Orange Roughy and Pelagic Armourhead for 2016 in the SEAFO Convention Area	2
CM	Rec01-08	On banning of deep-water shark catches	1
CM	Rec01-09	On banning of gillnets	1
Meeting	SEAFO 2005	Report of the 2nd Annual Meeting of the Commission	48
Meeting	SEAFO 2006	Report of the 3rd Annual Meeting of the Commission	63
Meeting	SEAFO 2007	Report of the 4th Annual Meeting of the Commission	48
Meeting	SEAFO 2008	Report of the 5th Annual Meeting of the Commission	59
Meeting	SEAFO 2009	Report of the 6th Annual Meeting of the Commission	176
Meeting	SEAFO 2010	Report of the 7th Annual Meeting of the Commission	152
Meeting	SEAFO 2011	Report of the 8th Annual Meeting of the Commission	111
Meeting	SEAFO 2012	Report of the 9th Annual Meeting of the Commission	223
Meeting	SEAFO 2013	Report of the 10th Annual Meeting of the Commission	104
Meeting	SEAFO 2014	Report of the 11th Annual Meeting of the Commission	80
Meeting	SEAFO 2015	Report of the 12th Annual Meeting of the Commission	284
Scientific	SC Report 2005	Report of SEAFO Scientific Committee, 2005	26
Scientific	SC Report 2006	Report of SEAFO Scientific Committee, 2006	59
Scientific	SC Report 2007	Report of SEAFO Scientific Committee, 2007	56
Scientific	SC Report 2008	Report of SEAFO Scientific Committee, 2008	69
Scientific	SC Report 2009	Report of SEAFO Scientific Committee, 2009	78
Scientific	SC Report 2010	Report of SEAFO Scientific Committee, 2010	52
Scientific	SC Report 2011	Report of SEAFO Scientific Committee, 2011	91
Scientific	SC Report 2013	Report of SEAFO Scientific Committee, 2013	65
Scientific	SC Report 2014	Report of SEAFO Scientific Committee, 2014	127
Scientific	SC Report 2015	Report of SEAFO Scientific Committee, 2015	152

Table 3. Documents sourced for case study analysis of the South Pacific Regional Fisheries Management Organisation (SPRFMO), with a total of 19 documents separated into four different categories.

Category	Name	About	Pages
General	SPRFMO 2013 Annual Report	2013 Annual Report	3
General	SPRFMO 2014 Annual Report	2014 Annual Report of the Commission	2
General	SPRFMO Convention Text	Convention on the Conservation and Management of High Seas Fishery Resources in the South Pacific Ocean	50
CM	SPRFMO CMM 4.13	Conservation and Management Measure for the Measurement of New and Exploratory Fisheries in the SPRFMO Convention Area	6
CM	SPRFMO CMM 1.02	Conservation and Management Measure for Gillnets in the SPRFMO Convention Area	1
CM	SPRFMO CMM 2.06	Conservation and Management Measure for the Establishment of the Vessel Monitoring System in the SPRFMO Convention Area	4
CM	SPRFMO CMM 4.03	Conservation and Management Measure for the Management of Bottom Fishing in the SPRFMO Convention Area	6
CM	SPRFMO CMM 4.09	Conservation and Management Measure for minimising bycatch of seabirds in the SPRFMO Convention Area	9
CM	SPRFMO CMM 4.10	Conservation and Management Measure for the Establishment of a Compliance and Monitoring Scheme in the SPRFMO Convention Area	23
CM	SPRFMO CMM 4.15	Conservation and Management Measure on Vessels without Nationality in the SPRFMO Convention Area	1
CM	SPRFMO resolution	Establishing a Preparatory Conference for the Establishment of the South Pacific Regional Fisheries Management Commission	2
Meeting	SPRFMO 2013	First Meeting of the Commission of the South Pacific Regional Fisheries Management Organisation	4
Meeting	SPRFMO 2014	Second Meeting of the Commission of the South Pacific Regional Fisheries Management Organisation	4
Meeting	SPRFMO 2015	Third Meeting of the Commission of the South Pacific Regional Fisheries Management Organisation	4
Scientific	SPRFMO SC 2013	Report of the 1st Scientific Committee Meeting	45
Scientific	SPRFMO SC 2013 ABNJ	The ABNJ Deep-Sea Project	15
Scientific	SPRFMO SC 2014	Report of the 2nd Scientific Committee Meeting	34
Scientific	SPRFMO SC 2014 Bottom Fishing	SPRFMO Bottom Fishing Conservation and Management Overview	9
Scientific	SPRFMO SC 2015	Report of the 3rd Scientific Committee Meeting	44

A document is a written text produced by an individual or organisation for an express purpose (Mogalakwe, 2006). For my research, I was interested in documents produced by CCAMLR and my two RFMO case studies. The documents were free, easy to find, and obtained through the websites of the organisations. Four types of documents were sourced for each of the fisheries organisations: general documents such as convention texts, annual meetings, conservation measures and resolutions, and scientific committee reports. For conservation measures and resolutions, only those relevant to EBM were selected. Conservation measures were relevant if they addressed bycatch, protected areas, and climate change, or if they specifically referenced ecosystems and environmental protection. I limited the research period to 10 years, with documents ranging from no earlier than 2005 and no later than 2015. The document analysis was restricted to 10 years to create a manageable pool of resources, and to limit the scope of the study to recent developments in the field of EBFM. The research itself was conducted from early 2016 to early 2017, so documents for the 2015/2016 season were excluded as they only became available after the analysis had been completed. A total of 81 documents were collected, with 33 for CCAMLR (Table 1), 29 for the South East Atlantic Fisheries Organisation (Table 2), and 19 for the South Pacific Regional Fisheries Management Organisation (Table 3).

Documents were imported into a software package NVivo and organised into separate folders depending on the types of documents and the different case studies. NVivo is a Qualitative Data Analysis tool allowing users to code data into relevant nodes or themes (Hilal & Alabri, 2013). Document analysis requires sifting through a vast amount of data, ignoring sections that are not relevant to the research questions, and coding pertinent information to be sorted later. Without software, this process would be much more time-consuming. By using NVivo, I could highlight or 'code' relevant sections of a document to a research theme, or 'node'. A node in NVivo is the equivalent of a sticky note, indicating the theme the highlighted section belongs to (Wong, 2008). Nodes are organised within the software, meaning that all sections coded across different documents for the same node can be accessed in one place, making it easier to analyse. NVivo helps to speed up the process of organising data according to coded themes, but the researcher is still responsible for creating categories and deciding what to code (Wong, 2008).

To code in NVivo, I looked for words, sentences, or paragraphs relevant to one of six research themes. I then highlighted the section of interest, and added it to a node. Nodes were selected prior to coding to guide the coding process, and make it easier to read through long documents by only searching for appropriate content. As part of a deductive content analysis approach, I created nodes that were

relevant to my research question and literature on EBM and the EAF. The nodes used and rationale behind them are listed in Table 4. Initially, I started out with five nodes, each corresponding to different EBM approaches: EAF (for the ecosystem approach to fisheries), spatial, integrated, resilience, and strategic. By using a structured, predetermined set of themes, I was only looking for sections of text that fit the categories I had created (Elo & Helvi, 2007). However, I used an inductive analysis when coding the first documents to ensure the categories were effective when used in the context of the analysis, and to remain flexible and responsive to new potential nodes. Key themes and ideas emerged from the text while I was reading, leading to the creation of an additional node – precautionary management, incorporating mentions of bycatch measures, the precautionary approach, and sustainability. Sections of text relevant to the new node were coded retrospectively for documents I had already read. This initial inductive approach allowed me to better conceptualise my research themes and broaden the coding process to incorporate ideas and concepts I had not considered prior to the document analysis.

Table 4. Nodes used in NVivo and rationale for the different research themes.

Node	Rationale
Precautionary management	Precautionary, sustainable, or conservation-oriented management measures relevant to the research themes
EAF management	EAF management beyond a single-species perspective, including impacts on dependent species and the wider ecosystem
Spatial management	Spatial measures to manage the impacts of fisheries on the environment, such as marine protected areas, bioregionalization, restrictions around vulnerable marine ecosystems, and elements of marine spatial planning
Strategic management	Evidence of a vision for the future, or a bigger picture, including incorporation of climate change impacts and scenario planning
Resilience management	Discussion of the concept of resilience in relation to the ecosystem approach to fisheries management
Integrated management	Moving beyond species-management to consideration of wider sectoral uses of marine space

Later in the coding process, for situations where a section of a document was not directly related to a node but potentially relevant to a research question, a note was added in the form of a linked memo in NVivo. Memos allowed for emerging themes or questions to develop without needing to add a new node, and repeating the coding process for all documents (Bowen, 2009; Wong, 2008). There was no need to create a new node after the initial inductive analysis, as I felt the existing nodes were sufficient and additional ideas or concerns were captured in memos or written down as a stand-alone note within

the software. In the analysis, these emerging themes are considered alongside the research themes as supplementary support when addressing the research questions.

To code documents ranging from 50 to over 700 pages, I used a word search in NVivo to find sections relevant to the research node. Only the first word in the node was used, and NVivo automatically captured any derivatives of the word, thereby ensuring the concept was covered in full and all instances retrieved in the search. This process was repeated for the EAF, resilience, integrated, spatial, and strategic nodes, for example using the word 'ecosystem' for the EAF (Figure 4).

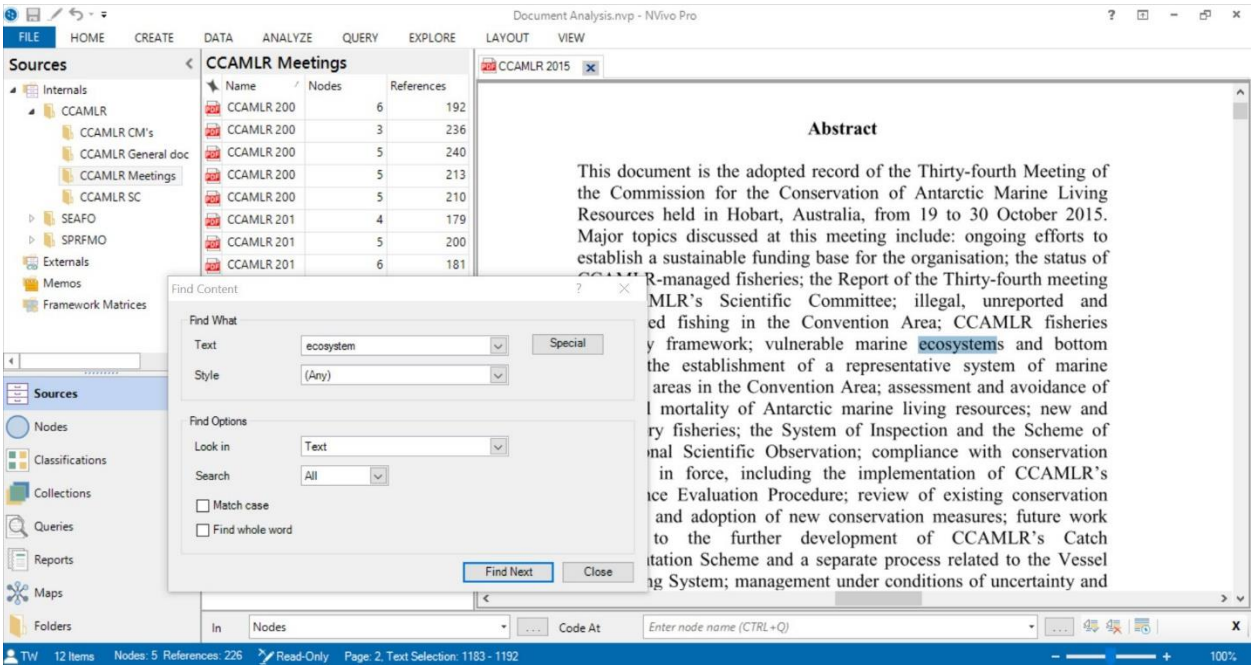

Figure 4. Screenshot of NVivo showing (from left to right) case studies, folders of different types of documents, individual documents listed by year, and an open pdf document with a word search for the word 'ecosystem'.

For the precautionary node, which consisted of different concepts, I searched for the words sustainable and conservation as well as precautionary. Each occurrence of the word present in the document was reviewed, but only relevant content coded. This allowed large documents to be processed with marginal room for error by drawing attention to specific sections, rather than searching for them manually by reading every sentence. A long document, such as an annual meeting report, may contain more content related to administration and finance than EBM, for example. A word search was much more efficient and less time consuming than reading through the whole document. However, a possible limitation of using a word search was missing sections of text that may have been relevant to a research theme, such as spatial management, but under a different term, such as MPAs, or marine

protected areas. To combat this limitation, I read through entire sections where the heading appeared in a word search, such as 'spatial' in the heading titled 'Spatial management of impacts on the Antarctic ecosystem' for the 2015 CCAMLR Scientific Committee meeting. Similar concepts are organised within subsections, including MPAs and vulnerable marine ecosystems, or VMEs.

For shorter documents, each sentence was read and reviewed with a list of the nodes to search for on hand for consistent coding. Once the documents were coded, I analysed the themes outside of NVivo by exporting the coded content for each node and looking at patterns and relationships. I organised the content according to case study, types of document (e. g., convention texts), and then by year for each node, or research theme. Findings of the document analysis are presented from chapter four onwards.

In the next chapter, research on EBM and the implementation of the EAF is reviewed, with a focus on CCAMLR and my case studies in the South East Atlantic and South Pacific Ocean.

3. Literature review

EBM can be a difficult concept to understand. At face value, it seems almost simple. An ecosystem approach is a movement away from management that only considers one part of a system in isolation from all the others. But systems, whether they be ecological, social, or governance, do not work in isolation. And for marine ecosystems facing a myriad of threats from ocean uses and more widespread impacts such as climate change, management in isolation is no longer a viable solution. This is a discourse which has played out in the scientific arena for the past four decades (Curtin & Prellezo, 2010). Scientists, policy makers, and resource managers no longer debate the necessity for EBM and approaches like it (Levin et al., 2009). Single species management approaches are by nature insufficient to protect other components of the ecosystem, or the ecosystem at large. There is a mismatch of scale, and in objectives. EBM can be seen as an alternative to traditional fisheries management, which is poorly placed to deal with the threats facing ecosystems, of which fisheries are a part of and also have an impact on (Crowder et al., 2008; Curtin & Prellezo, 2010; Long et al., 2015). Rather, the recent focus of discussion around EBM is on the 'how'.

Implementation of EBM has lagged behind discussion of the utility of EBM, and there is little guidance available on how to practically implement an EBM approach (P. S. Levin et al., 2009; Patrick & Link, 2015). In the Southern Ocean, CCAMLR has consistently met the objectives of its mandate in regard to conserving marine living resources by implementing an EAF, but to what extent does this align with the full set of responsibilities, objectives, and goals of EBM, as defined in the literature, and as interpreted in its mandate? This is difficult to determine, not in the least because of the discrepancy between the two definitions, with EBM cross-sectoral, and the EAF a sectoral interpretation largely restricted from progressing to full EBM by regulatory mechanisms. Also, within an EAF, organisations may have different levels of implementation, which leads to the question of how ecosystem-based is a particular ecosystem approach? There is a danger of using EBM and EAF interchangeably, and I would argue that greater clarity on the different approaches can lead to a better understanding of what is being done currently, and what can be done in the future within the ecosystem management space.

The aim of this literature review is to clarify what it means exactly to take an ecosystem approach to managing fisheries. I will first look at the definitions of EBM and the EAF, and where each approach sits in relation to each other, and for the purpose of my research. I will then look at best practice in EBM, exploring different elements and key concepts. Finally, implementation of EBM will be explored, leading

into a discussion of the results of the document analysis on implementing EBM in the following chapters.

3.1 Defining an ecosystem approach

There is no one definition of what constitutes an ecosystem approach. However, there are useful interpretations which can be used to guide managers when developing and implementing an ecosystem approach for managing marine resources. Firstly, it is crucial to understand what exactly is meant by an ecosystem approach, or EBM. The aim of a literature review on EBM by Curtin and Prellezo (2010) was to define what EBM is and why it is needed. The authors describe EBM as a broader view in comparison to traditional management, which takes into consideration how components of ecosystems are interconnected and interdependent, while also realising the importance of ecosystems in providing services for humans that are taken for granted. The Curtin and Prellezo (2010) review was heavily influenced by an earlier paper by Arkema, Abramson, & Dewsbury (2006), which produced a set of specific criteria to characterise EBM corresponding to ecology, management, and the human dimension, in addition to general criteria on sustainability and ecosystem health. Arkema and co-authors note that an EBM definition is useful only if it informs management actions, and a translation of ideas was to occur. They found that management interventions, or actions taken to achieve an objective, generally focus on general criteria, with only a small amount meeting the criteria for ecology and management. This is important because in their analysis, specific criteria of EBM were lost in the transition from definition to objective, and objective to intervention. When general criteria inform interventions, they fail to account for the full breadth of principles (economic, ecological, management, social) that constitute EBM, limiting its efficiency and execution. A recommendation by Arkema and co-authors is to improve communication between scientist and management agencies to better understand EBM, with inconsistencies in the terminology potentially acting as a barrier to communication. Understanding is crucial to successful implementation of EBM, and implementation of EBM important to manage human activities in a way that promotes the sustainable use of resources consistent with international conservation obligations.

Several definitions have been useful in developing an understanding of EBM for the purpose of this literature review, and my research. Long and colleauges (2015) developed a set of key principles that define EBM from a selection of major EBM publications, producing the definition of EBM as an interdisciplinary approach with ecological, social, and governance principles and the aim of achieving sustainable resource use. Their definition also acknowledges the use of scientific knowledge and

monitoring, the connections, integrity, and biodiversity of ecosystems, the uncertainty of dealing with the dynamic nature of ecosystems, and a management process that is integrated, adaptive, and reflecting of societal choice. Integrated is a key word in defining EBM, and there are many ways in which the term could be interpreted within an EBM definition. A consensus statement issued by scientists in the United States describes EBM as an integrated approach, and calls for comprehensive EBM to address challenges facing the oceans (McLeod et al., 2005). Within this definition alone, an integrated approach considers multiple different levels. Integration involves the linking up of separate parts into a cohesive whole, and in the ecosystem space, EBM is an integrated approach because it encompasses the entire ecosystem and not just components. It also deals with the interconnectedness within systems, such as interactions between a species targeted by harvesting and key services provided by the ecosystem, as well as the connection between systems such as the land and the sea, and cumulative impacts across different sectors. Integration operates at different scales, from an entire ecosystem, to how parts of that ecosystem interact, but also within different contexts, incorporating the social, the economic, and management principles of EBM into an approach that links together elements usually considered in isolation.

For the purpose of my research, the EBM definition I used is of EBM as an integrated approach to managing marine resources. I consider 'ecosystem approach' to be an overarching term that covers a suite of ecosystem-based approaches, of which EBM is merely one (UNEP, 2016). This is consistent with emerging discussion of EBM as an evolution from traditional management approaches through to comprehensive EBM, with different levels of implementation (Hilborn, 2011; Link & Browman, 2014). With respect to a potential hierarchy, an EAF sits within an EBM approach, but they are both ecosystem approaches to resource management. Link and Browman (2014) introduce a conceptual way of looking at EAF as one level of EBM within the fisheries sector. Classical, or traditional, fisheries management is described as having a stock status and stock productivity focus, where management is solely concerned with one species that constitutes a discrete stock in the fishery. Their description of EAF is one with a stock focus, but with the potential for consideration of different species, and EBFM, which follows EAF, looking at the productivity and status of the whole ecosystem, and not just species of economic value from a fisheries perspective. The difference between EAF and EBFM in Link and Browman's conceptual framework is that EBFM has an ecosystem emphasis, whereas EAF only has an inclusion of ecosystem considerations. This is an interesting delineation, with EAF viewed as only a slight improvement on traditional management, and still indicative of a stock focus, rather than a fishing sector focus. I would argue that more evidence is needed to support this framework, especially on the separation between

EAF and EBFM, as examples from fisheries organisations were lacking on the notes used to discriminate between the different levels. Finally, EBM is described as sectoral, and following on from EBFM.

For the purpose of my research, I define the EAF as an EBM approach within the fisheries sector, carrying over the principles and themes of EBM, such as integration, but on a much smaller scale. The FAO, who have provided guidance on both EBM and the precautionary approach to fisheries, define the EAF as an integrated approach, taking into account the biotic, abiotic, and human components of ecosystems – again, connecting separate parts into a comprehensive whole (Bianchi, 2008). This contrasts with the Link and Browman description of EAF, and has more in common with their account of EBFM. The EAF definition of the FAO is more similar to the definition used by Convention on Biological Diversity (CBD), which describes the ecosystem approach as a strategy for integrated management, promoting the conservation and sustainable use of land, water, and living resources (Vierros, 2008). An ecosystem approach can be implemented in different ways using a variety of tools, and in the marine environment some of these tools contribute to a best practice for EBM and the EAF.

3.2 Best practice in EBM

When thinking about EBM best practice in the fisheries sector, it is important to have a good understanding of the precautionary approach to fisheries management. The essence of a precautionary approach is taking account of uncertainties associated with ecosystems and ecosystem components when making management decisions (Hanchet et al., 2015). A reoccurring criticism in the EBM literature is the challenge of implementing EBM in data-poor regions, or even at all, with the perception that ecosystems are too complex to be able to understand and incorporate information into decision-making processes (Murawski, 2007; Patrick & Link, 2015). While managers accept that it is impossible to know everything about the ecosystem, it is possible to understand the likely outcomes of a management intervention (Murawski, 2007). One example of this can be seen in the CCAMLR Krill fishery, where different potential outcomes are evaluated as part of a precautionary approach. Using ecosystem and biological parameters, a krill stock model calculates population sizes of krill in response to different levels of fishing mortality (Croxall & Nicol, 2004). Decision rules incorporate the effects of harvesting on other species, comparing the amount of krill that will escape the fishery for a given fishing effort to then become available for predators that depend on krill (Constable et al., 2000). CCAMLR also employs a precautionary approach when creating new or exploratory fisheries, with the caveat that the fishery must not develop faster than the ability of CCAMLR to manage it, in accordance with the conservation principles of its mandate (Trathan & Agnew, 2010; Willock & Lack, 2006).

Precautionary management is an approach that accepts the uncertainty inherent in managing human activities from an ecosystem point of view. Rather than not taking any action, or worse, taking it blindly, precautionary management allows managers to use the best available knowledge to move towards an EBM approach, and is essential best practice in an EAF. Similarly, adaptive management takes account of new information when it becomes available, and incorporates it into the next iteration of decision-making (Murawski, 2007). Adaptive management is a complementary approach often incorporated into precautionary management as a way of reducing uncertainty.

CCAMLR is often referred to as a prime example of best practice in the EBM space, with a broad mandate that accommodates ecosystem considerations in management decisions, and the use of precautionary management and best available science (Miller & Slicer, 2014; Mooney-Seus & Rosenberg, 2007). Best practice in EBM falls under several different areas corresponding to key principles of EBM, such as taking an integrated approach, and incorporating a wider view of the ecosystem. One area of best practice is that of co-operation with other organisations and within the organisations themselves for successful collaboration to meet the goals and objectives of EBM (Miller & Slicer, 2014). Precautionary management is a required element of best practice in EBM, with a major review of best practice by Willock and Lack (2006) recommending RFMO's account for the precautionary approach explicitly by amending mandates or adding a resolution. Finally, best practice in EBM also requires proactive measures to account for the impacts of fishing on the ecosystem (Willock & Lack, 2006). One way CCAMLR accounts for impacts on the ecosystem is through the CCAMLR Ecosystem Monitoring Programme (CEMP), which monitors key species that could be potentially impacted by overharvesting of a target species, such as Krill (Constable et al., 2000). CCAMLR also establishes a total allowable catch, or TAC, for bycatch species unintentionally caught in a fishery targeting a different species (Mooney-Seus & Rosenberg, 2007).

Long and colleagues (2015) ranked a set of 15 key principles of EBM from low importance to high importance, with the most important principle 'consider ecosystem connections'. Other key principles were adaptive management, which was the second most-important, accounting for different scales, use of scientific knowledge, and integrated management. Interestingly, key ecological principles such as consideration of ecological integrity, biodiversity, and sustainability rank lower than the management-oriented principles, for example, that of stakeholder involvement and adaptive management. This suggests that the management aspects of EBM are just as important as the ecological, and something to keep in mind when thinking about implementation.

3.3 Implementation of EBM

RFMO's and fisheries management organisations have varied in their implementation of EBM through an EAF, but CCAMLR once again provides an example to other RFMO's of best practice in this space. However, Croxall & Nicol (2004) note that although the principles of the CAMLR convention preceded formalised guidance on the precautionary approach and EBM, the application of key principles proceeded slowly, and the Commission focused initially on reactive management of finfish stocks that had been heavily exploited. Implementation of EBM is important in CCAMLR, especially from an integrated management point of view, as the Southern Ocean is an important component of the Earth System. Marine ecosystems in Antarctica affect biogeochemical cycles, sustain a rich and varied array of life, and support global food security through the provision of marine resources (Murphy & Hofmann, 2012).

In CCAMLR, decision-making is by consensus, which means that members can object to a conservation measure, thus lessening the impact of the regulation (Clark & Hemmings, 2001). Consensus decision making, which was implemented due to the unresolved sovereignty issues in the Antarctic, can slow down progress if a member state blocks a proposed measure but it can also encourage compromise (Clark & Hemmings, 2001; Kock, 2007). However, Dodds (2000) notes that consensus decision making is too conservative, and environmentally ineffective. This is evident with regard to MPA's in the Southern Ocean, where fishing interests clash with conservation objectives (Clark & Hemmings, 2001). Kock (2007) suggests that consensus may slow down the rate of progress but ultimately encourages compromise. This is perhaps evident in the development of the proposal for the Ross Sea MPA, which reached consensus in 2016 after years of negotiation and opposition by fishing states, ending in a compromise of 35 years and special sections reserved for science and fishing activity. When CCAMLR was established, fishing states were a minority and the majority were interested in conservation (Jacquet et al. , 2016). Over time the ratio has changed, with potential implications of a conflict of interest where fishing states oppose measures that have a negative economic impact (Brooks et al., 2014). Molenaar (2001) makes the point that the term 'consensus' is not defined in the CCAMLR convention, but is interpreted as an absence of objection. Consensus may potentially be a contentious issue if member states place economic interests above the EBM objectives of the Convention, and restrict the ability of CCAMLR to implement an effective EAF. Conversely, in SPRFMO, if members cannot reach consensus on an issue, a three-fourths vote is employed, with any objections specified in

detail, and an alternative but equivalent measure suggested (Schiffman, 2012). In SEAFO, decisions are made on the basis of consensus, with non-acceptance to be explained in writing (Jackson, 2002).

One of the biggest challenges facing environmental management in the Southern Ocean is that of Illegal, Unregulated, and Unreported (IUU) fishing (Schiffman, 2009). CCAMLR has implemented the Catch Documentation Scheme (CDS) to track Toothfish landings, but other issues such as enforcement and monitoring remain (Dodds, 2000; Schiffman, 2009). There is also the possibility that future warming in the Antarctic may open up more areas of the Southern Ocean and increase accessibility, and thus the risk of additional IUU fishing, as well as other human activity (Trathan & Agnew, 2010). An additional issue with IUU fisheries is the lack of compliance with CCAMLR conservation measures for the reduction of bycatch, particularly seabird bycatch (Kock, 2000). IUU fishing undermines the management of Antarctic marine resources, and is one instance in which conservation measures are in place, but implementation and compliance are falling behind.

The ecosystem impacts of fisheries should be considered in a broader context (Schiffman, 2009), and Grant, Hill, Trathan, & Murphy (2013) note in a review of ecosystem services of the Southern Ocean that management of fisheries should consider impacts on all ecosystem services. Ecosystem services are the beneficial services such as climate regulation and the provisioning of resources that ecosystems provide. But in terms of implementing spatial measures as part of an EBM approach, there are several tools that can be used.

Information on bioregions can be used to prioritize areas that are vulnerable, or under-represented (Grant, Hill, & Fretwell, 2013). This is part of a systematic conservation planning (SCP) approach, which takes into account human use of the environment, existing management, and representativeness of biodiversity values in different areas (Margules & Pressey, 2000). Grant and colleagues (2013) note that a catch limit of zero in a management area does not equate to any form of systematic conservation planning. A more comprehensive, and arguably more intentional, approach is needed, especially with the increasing pressure of human activity in the region (Ardron, et al., 2008). Another tool to implement EBM is marine spatial planning (MSP), which focuses on zoning areas of the ocean for different uses, and can help balance or eliminate conflict between different users and objectives (Rassweiler et al., 2014). The result of an MSP process is a comprehensive plan for a marine region, of which ocean zoning is an element (Ehler & Douvere, 2007). MSP is a practical tool that can move implementation of EBM forward by bridging the gap between science and practice (Katsanevakis et al., 2011).

Finally, MPAs are an integral tool in a broader spatial management approach, and can be used for different purposes, such as the protection of vulnerable marine ecosystems (VMEs) and the development of ecosystem resilience against human impacts (Scott, 2012). Resilience is an important concept, and is used widely in different contexts. In the ecological sense, resilience is the capacity of an ecosystem to remain in a certain state in the face of change, with a desirable state one that continues to function and provide ecosystem services (Fujita et al., 2013). Resilient ecosystems are often mentioned as a desired outcome or objective of EBM, because a loss of resilience can lead to potentially irreversible regime shifts, whereas more resilient ecosystems are much better placed to absorb changes (Folke et al., 2004). A resilient ecosystem is a robust ecosystem that continues to function in the face of disturbance (Levin & Lubchenco, 2008), and is particularly important in an era of global change.

CCAMLR created the first Antarctic MPA in the South Orkney Islands in 2009, with strict regulation on fishing and scientific research, but there is poor representation of habitat and geographic coverage (Scott, 2012). The World Conservation Union's 2002 World Summit on Sustainable Development (WSSD) called for a global representative system of MPAs, of which Antarctic MPAs would be a significant component (Grant, 2005). Bioregionalisation is an approach that partitions a broad area into regions with distinct environmental characteristics, with the aim of informing EBM (Grant et al., 2006). As part of its bioregionalization program, CCALMR identified nine different planning domains, and in 2011 developed a framework for the establishment of marine protected areas (CCAMLR, 2012). The framework states that any CCAMLR conservation measures for MPAs are to be adopted and implemented consistent with international law. Scott (2012) notes that spatial management within the region has not been developed in accordance with the 1991 Environmental Protocol to the Antarctic Treaty, which states that MPAs should be established with a range of activities regulated, not just fishing. This is an important point, and one that is hinted at in the CCAMLR MPA framework. Maintaining ecosystem structure and function, as well as fostering ecosystem resilience, will require a broader suite of regulations that cover fishing, science activity, tourism, and potentially even bioprospecting (Scott, 2012).

Defining EBM is crucial to understanding what constitutes an ecosystem approach, and how to implement one. In the next chapter, I will look at the results of my document analysis on implementing EBM in CCAMLR and my two RFMO case studies.

4. Document analysis

In my document analysis, I categorized key sections of text under six themes to guide my research. As part of my analysis I created a hierarchy of these themes, adapting the ranking from similar conceptual frameworks encountered in the literature, and ranking them in order of complexity to better understand the different levels of implementation achieved in the case studies. Figure 5 shows the themes organised from precautionary management through to strategic management.

Figure 5. EBM research themes from document analysis of three different case studies – CCAMLR, SEAFO, and SPRFMO.

In this chapter, I will discuss the results of my document analysis on the implementation of EBM in CCAMLR, SEAFO, and SPRFMO, following the structure of my research theme hierarchy. The first section deals with precautionary management and the EAF, the second section is devoted to spatial

management, and the third and final section is on the themes of integrated, resilience, and strategic management.

4.1 Precautionary management and the EAF

The precautionary approach, which contains bycatch measures and rules about discharge and pollution, is ranked first on the hierarchy. These are the 'baseline' measures of EBM that are implemented in all three of the case studies – essentially, the bare minimum of an ecosystem approach. The EAF theme contains evidence that the organisation has thought beyond a single-species management approach, with mandates to consider the effects of its activities on non-harvested species and the wider ecosystem.

When thinking about the different themes of EBM, I looked specifically at how EBM was defined in the convention texts of the different organisations. Convention texts are the founding document of any regulatory instrument, such as an RFMO, and set out the rules and guidelines operations in the convention area are to adhere to. In my research hierarchy, precautionary management acts as a precursor to more developed EBM approaches. For the precautionary theme, I was looking for evidence of a conservation focus or objectives relating to sustainability.

A simple keyword search in NVivo revealed that the CCAMLR convention text does not include the words 'sustainable', 'precautionary', or 'resilience'. However, the words 'ecosystem' and 'conservation' are included in the text. I would argue that in this instance the phrase 'rational use' could be a substitute for the word 'sustainable'. There has been much debate recently as to the meaning of rational use, with some members of CCAMLR with a vested interest in fishing interpreting rational use as a literal 'right' to fish (Brooks et al., 2014). Rational use is first mentioned in Article II of the CCAMLR convention text, where the first paragraph describes the objective of the convention as 'the conservation of Antarctic marine living resources', and the second paragraph elaborates that as a concept, or term, conservation in relation to the CAMLR convention includes rational use. The SPRFMO convention text also has a similar reference to rational use with the phrase 'responsible utilisation'. This is used in Article XX to include conservation measures to ensure the long-term sustainability of resources. It is an interesting expression, suggestive of the wording in the 1995 FAO Code of Conduct for Responsible Fisheries. Overall, rational and responsible both suggest the same interpretation, of using logic and the best available knowledge for decision-making.

Table 5. Ecosystem-based management (EBM) concepts and excerpts from key articles of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) convention text.

Key articles	EBM concepts	CCAMLR convention text
Article I	Ecosystem approach	'the complex of relationships of Antarctic marine living resources with each other and with their physical environment' (I.3)
Article II	Conservation	'The objective of this Convention is the conservation of Antarctic marine living resources' (II.1)
	Fisheries management	'For the purposes of this Convention, the term 'conservation' includes rational use' (II.2)
	Conservation principles	'prevention of decrease in the size of any harvested population to levels below those which ensure its stable recruitment' (II.3.a)
	Conservation principles	'maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources' (II.3.b)
	Conservation principles and ecosystem management	'prevention of changes or minimization of the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades, taking into account the state of available knowledge of the direct and indirect impact of harvesting, the effect of the introduction of alien species, the effects of associated activities on the marine ecosystem and of the effects of environmental changes' (II.3.c)
Article IX	Ecosystem management	'facilitate research into and comprehensive studies of Antarctic marine living resources and the Antarctic marine ecosystem' (IX.1.a)
	Wider fisheries management	'compile data on the status and changes in population of Antarctic marine living resources and on factors affecting the distribution, abundance and productivity of harvested species and dependent or related species and populations' (IX.1.b)
	Spatial protection and conservation	'the designation of the opening and closing of areas, regions or sub-regions for purposes of scientific study or conservation, including special areas for protection and scientific study' (IX.2.g)
	Wider fisheries management	'the taking of such other conservation measures as the Commission considers necessary for the fulfilment of the objective of this Convention, including measures concerning the effects of harvesting and associated activities on components of the marine ecosystem other than harvested populations' (IX.2.i)
Article XV	Wider fisheries management	'analyze data concerning the direct and indirect effects of harvesting on the populations of Antarctic marine living resources' (XV.2.c)

In Table 5, the key conservation articles of the CAMLR convention are set out alongside the relevant EBM concepts, and excerpts of the convention text that reference it. Even though the term 'ecosystem approach' is not mentioned in the text, the wording uses is perhaps representative of the era in which the CAMLR convention was written, signed, and adopted. CCAMLR is often considered a pioneer in EBM, with its management approach a precursor to the EAF, as the convention was adopted long before international regulations and guidance on the precautionary and ecosystem approaches were established (Garcia et al., 2003). Ecosystem considerations prompted the development of the convention, with the position of krill in relation to the rest of the Antarctic marine food web a key concern.

In Article II of the CAMLR convention key concepts of environmental-based management are referenced, if not defined as clearly as the equivalent concepts articulated by SEAFO and SPRFMO. Article I sets the scene for an ecosystem approach by defining Antarctic marine living resources as a 'complex' of relationships, both with each other, and their physical environment. The conservation principles of Article II protect recruitment of harvested populations, the relationship between harvested, dependent, and related populations, and the prevention or minimisation of changes that are not reversible. These principles seek to maintain the structure of populations and the relationships between Antarctic marine living resources while considering the impact of fishing as well as impacts upon the marine environment other than fishing. This is a key provision of EBM and goes beyond an EAF, which is conceptually more sectoral, and focuses on fisheries interacting with the ecosystem as opposed to a broader, more integrated activities view (Long et al., 2015). Article IV of the convention text outlines the need to facilitate research on the ecosystem and monitor changes to harvested and dependent species, as well as introducing measures for spatial protection in the form of closed areas for scientific study and conservation. Article IV also mandates the creation of Conservation Measures to fulfil the objectives of the convention, including measures regarding the effects of harvesting on components of the ecosystem other than the harvested species, such as bycatch. This essentially moving beyond single-species management into a broader ecosystem-based approach.

Table 6 presents the precautionary and ecosystem approaches of both SEAFO and SPRFMO, as defined in their convention texts. For the precautionary approach, both RFMOs have clear provisions describing how it is to be applied (widely), why it is needed (to protect resources and marine ecosystems), and that

Table 6. Precautionary and ecosystem approaches as defined in the convention texts of the South East Atlantic Fisheries Organisation (SEAFO) and the South Pacific Regional Fisheries Management Organisation (SPRFMO).

Approach	SEAFO	SPRFMO
Precautionary approach	"The Commission shall apply the precautionary approach widely to conservation and management and exploitation of fishery resources in order to protect those resources and preserve the marine environment." (VII.1) "The Commission shall be more cautious when information is uncertain, unreliable or inadequate. The absence of adequate scientific information shall not be used as a reason for postponing or failing to take conservation and management measures." (VII.2)	"The precautionary approach as described in the 1995 Agreement and the Code of Conduct shall be applied widely to the conservation and management of fishery resources in order to protect those resources and to preserve the marine ecosystems in which they occur, and in particular the Contracting Parties, the Commission and subsidiary bodies shall: (i) be more cautious when information is uncertain, unreliable, or inadequate; (ii) not use the absence of adequate scientific information as a reason for postponing or failing to take conservation and management measures; and (iii) take account of best international practices regarding the application of the precautionary approach" (III.2.a)
Ecosystem approach	"apply the provisions of this Convention relating to fishery resources, taking due account of the impact of fishing operations on ecologically related species such as seabirds, cetaceans, seals and marine turtles" (III.c) "adopt, where necessary, conservation and management measures for species belonging to the same ecosystem as, or associated with or dependent upon, the harvested fishery resources" (III.d) "ensure that fishery practices and management measures take due account of the need to minimise harmful impacts on living marine resources as a whole" (III.e) "protect biodiversity in the marine environment." (III.f)	"An ecosystem approach shall be applied widely to the conservation and management of fishery resources through an integrated approach under which decisions in relation to the management of fishery resources are considered in the context of the functioning of the wider marine ecosystems in which they occur to ensure the longterm conservation and sustainable use of those resources and in so doing, safeguard those marine ecosystems." (III.2.b)

the respective Commissions are directed to be more cautious when information is uncertain. The language used and reasoning behind the precautionary approach are similar between the two RFMOs, and this is perhaps due to the timing of the SEAFO convention, which was signed after the relevant guidelines were released by the FAO in 1995 and 2002. Also, the SPRFMO convention was adopted nearly a decade later, and could reference key international guidelines specifically, build on successful RFMO mandates in terms of best practice, and respond to the growing move away from single-species fisheries management. For the ecosystem approach, much like CCAMLR, there is no direct definition in the SEAFO convention text. Instead, key principles of the approach are referenced, such as the impact of fishing on non-harvested species, minimising harmful impacts on the ecosystem, and protecting biodiversity. The ecosystem approach in SPRFMO is clearly defined, owing once again to the recent developments and evolution in the language and definition of EBM. For instance, the SPRFMO convention is the only convention text among the case studies that mentions an 'integrated approach'. Taken in this context it is perhaps another way of describing the function of an ecosystem approach, but it could also reflect the increased move towards integrated management in the marine space

Table 7. Keywords applicable to an ecosystem-based management approach taken from the CCAMLR, SEAFO, and SPRFMO convention text preambles.

CCAMLR	SEAFO	SPRFMO
• safeguarding the environment • protecting the integrity of the ecosystem • conservation • cooperation • preservation of the environment	• conservation • sustainable use • safeguarding ecosystems • safeguarding environments • precautionary approach • responsible fisheries • cooperation	• conservation • sustainable use • safeguarding marine ecosystems • cooperate • performance reviews • IUU fishing • preserve biodiversity • maintain integrity of ecosystems • avoid adverse impact • minimize risk • best scientific information • application of the precautionary approach • ecosystem approach to fisheries management

Table 7 shows the difference in wording between the preambles, i.e. the introductory texts describing the reasoning behind and the aims of the respective Conventions. The CAMLR convention mentions

conservation, protection, preservation, and safeguarding with regard to the environment – not specifically defining an ecosystem approach but in essence describing one. The SEAFO convention mentions the precautionary approach explicitly but only describes components of an ecosystem approach, including that of 'responsible' fisheries. The SPRFMO convention is the most detailed of all the case studies, specifically mentioning both the precautionary and ecosystem approach, as well as multiple measures characteristic of an ecosystem approach, and, indeed, the CCAMLR approach – using best scientific information, avoiding impact, minimizing risk, preserving biodiversity, cooperation, and performance reviews.

Although the convention texts of the case studies differ in wording, they all offer similar objectives consistent with a precautionary approach and an EAF, moving beyond single-species management to a wider consideration of the effects of fishing on non-harvested species and their environment.

4.2 Spatial planning in the marine environment

CCAMLR, SEAFO, and SPRMFO all have provisions in their founding documents to protect the wider ecosystem, and not just harvested resources. However, the spatial theme is where the case studies begin to diverge. Spatial management includes provisions for spatial protection such as bioregionalization as part of a wider systematic conservation planning approach, MPA's, and move-on rules to protect vulnerable marine ecosystems (VMEs). For CCAMLR, discussion of the spatial challenges inherent in fisheries management in the Southern Ocean is evident in meetings of the Scientific Committee from 2005, through to discussion of Bioregionalisation and a network of MPAs in 2007, and consideration of biodiversity in a systematic conservation planning approach. In 2012 and 2015 the designation of MPAs was discussed as a means of demonstrating to the world the position of CCAMLR as a conservation-based organisation, and reaffirming CCAMLR as a precautionary convention based on the ecosystem approach. A special meeting was held in 2013 on Marine Protected Areas where it was noted that the designation of MPAs represented a 'logical approach' to achieving the objectives of the Convention, specifically in relation to whole ecosystems and the viability of regional biodiversity.

Discussion of the need to establish MPAs in the CCAMLR convention area has led to the development of priority areas and subsequent planning domains, a work plan towards the designation of a representative network of MPAs, a conservation measure (CM 91-04) on a general framework for the establishment of MPAs, as well as the world's first high seas MPA in the South Orkney Islands in 2009 (Smith et al., 2016). CCAMLR members also agreed upon the designation of the Ross Sea MPA in 2016, after several years of deliberations and negotiations in annual and Scientific Committee meetings.

However, there are caveats to CCAMLR's progress with MPAs. Smith and colleagues (2016) and Brooks, (2013) question the South Orkney Islands MPA in that key areas of high conservation value adjacent to the Islands are not protected, and a section of the proposed MPA was removed after a member expressed concern over a future crab fishery in the region. This is continued with Brooks & Ainley (2017) going on to state that the South Orkney Islands set a 'problematic precedent' for the establishment of 'meaningful' MPAs within the CCAMLR area. This is perhaps a redundant criticism in light of the Ross Sea MPA, because when it comes into force on December 1st, 2017 it will be the world's largest Marine Protected Area, with specific zones for general protection, krill research, and special research (Figure 6).

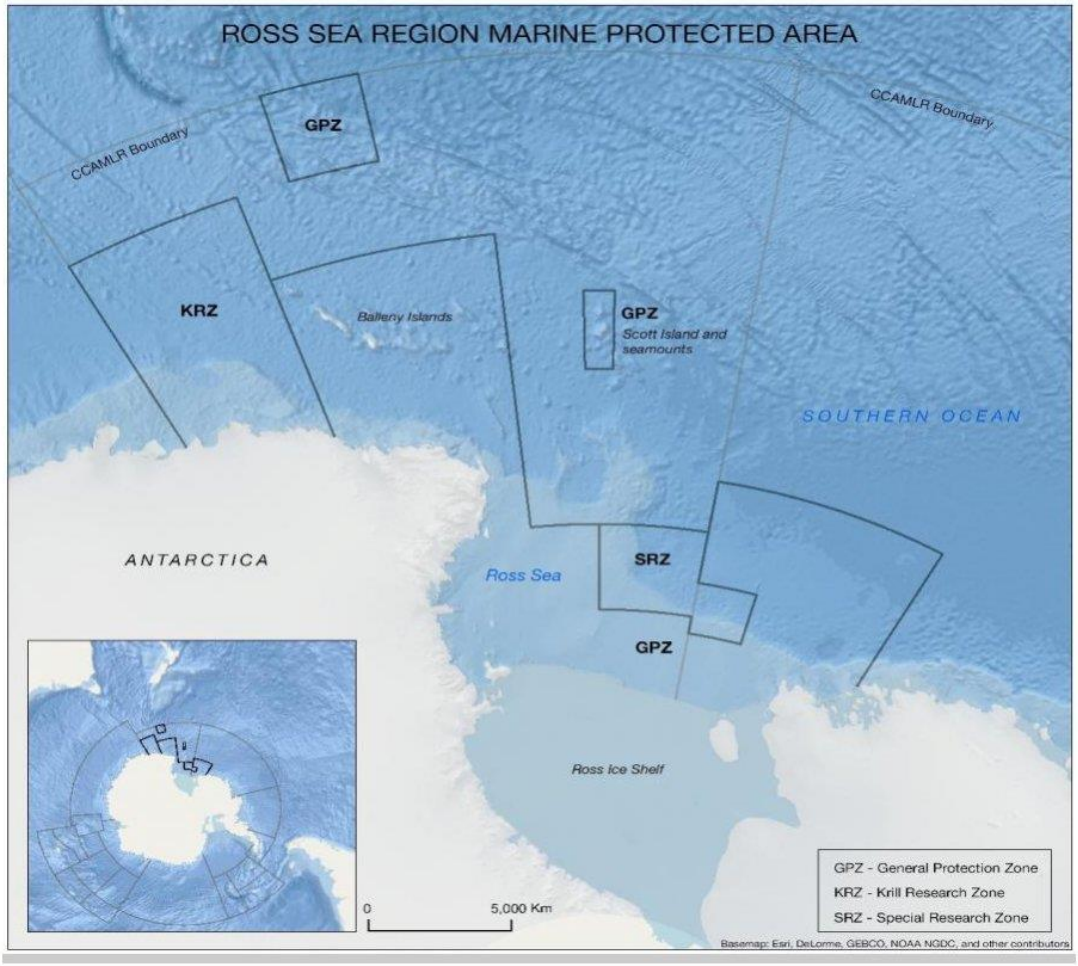

Figure 6. The Ross Sea Marine Protected Area showing zones for general protection, krill research, and special research (MFAT, n.d.).

The Ross Sea MPA has a set duration of 35 years, with a decision by consensus needed to continue it on after this time, and a review of objectives every five years. It is unclear if benefits of the MPA would be

evident in 35 years. Most MPAs in exclusive economic zones are protected in perpetuity, and research shows that time of protection is one of the key contributing factors to an MPA achieving conservation outcomes (Edgar et al., 2014). However, MPAs can be established for a variety of different objectives, not just protection. Research on separating the effects of harvesting from environmental change is critical to the ecosystem objectives of CCAMLR, and toothfish tagging efforts in the Ross Sea contribute to increased understanding of the structure of populations, feeding back into sustainable management of the fishery (MFAT, n.d.). But spatial management also comes with its own restrictions and limitations, and it is important to be aware of the spread of fishing effort to avoid concentration in any one area.

CCAMLR has made significant progress establishing MPAs as part of an EBM approach. Spatial management in SEAFO and SPRFMO is more centred around the protection of Vulnerable Marine Ecosystems (VMEs) and measures for bottom fisheries in line with provisions from the United Nations General Assembly Resolution 61/105, calling on states and RFMOs to regulate bottom fisheries in accordance with the precautionary and ecosystem approaches to fisheries management (Parker et al., 2009; Wright et al., 2015).

Figure 7 shows the current closures in the SEAFO convention area, with conservation measure 30/15 detailing the regulations on bottom fishing and VMEs in the area. The SPRFMO conservation measure on the management of bottom fishing, CMM 03-2017, which supersedes the 2016 CM collected as part of my document analysis, has the following objective:

> *"To promote the sustainable management of bottom fisheries including target fish stocks as well as non-target species taken as bycatch, in these fisheries, and to protect the marine ecosystem in which those resources occur, including,* inter alia*, the prevention of significant adverse impacts on vulnerable marine ecosystems"*

As part of this conservation measure, members engaging in bottom fishing in the SPRFMO convention area must prepare a bottom fishing footprint, ensure 100% observer coverage for vessels using trawl gear, and cease activities within five nautical miles where there is evidence of an encounter with a VME, which is determined by the use of indicator species associated with VMEs. The regulations for bottom fishing in SEAFO are similar to SPRFMO, with rules for exploratory fisheries including new bottom fishing gear, and encounter protocols with thresholds for VME indicator taxa with a move-on rule of two nautical miles.

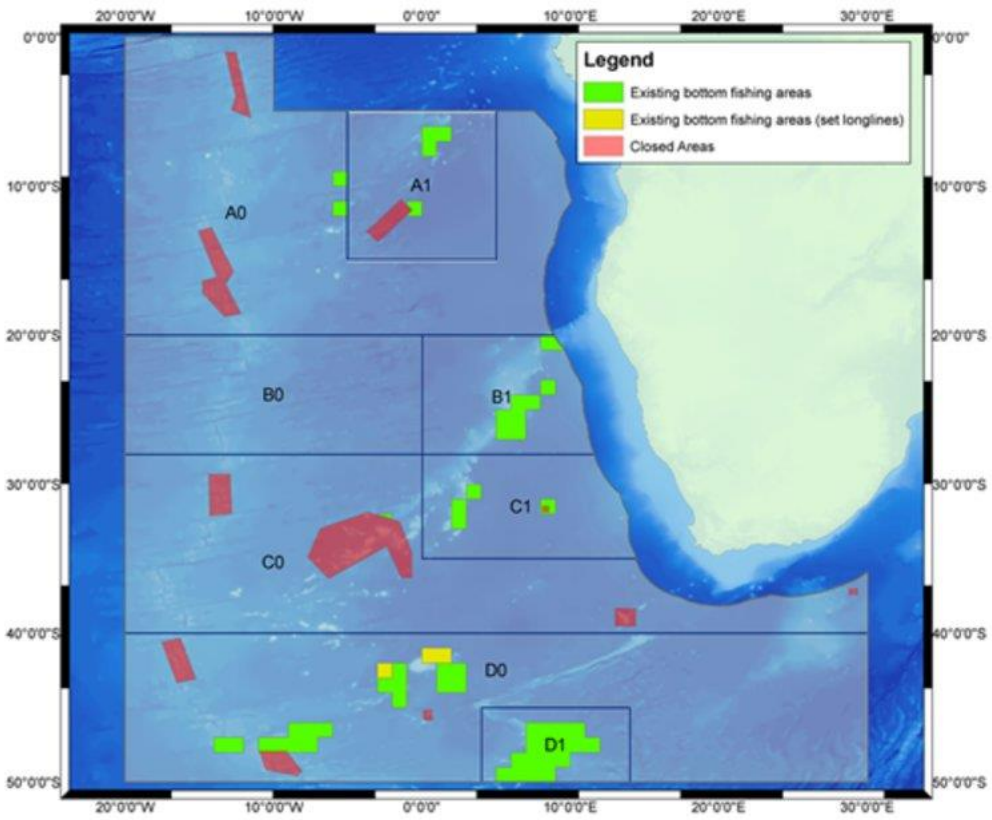

Figure 7. Map of the SEAFO convention area showing closures for Vulnerable Marine Ecosystems (VMEs) taken from the SEAFO website.

On the SEAFO website is an outline of management measures put in place under the ecosystem and precautionary approach to fisheries, including measures to reduce the incidental bycatch of seabirds, increase reporting of bycatch of sea turtles with the aim of reducing mortality, and to protect deep-sea sharks through reporting and full retention of the shark carcass to discourage shark finning. SEAFO has a ban on gillnets in the convention area, protocols for retrieving lost gear, and a strategy to monitor and control fisheries. All vessels are banned from making transhipments to cut down on illegal, unreported, and unregulated (IUU) fishing, and are required to have an independent scientific observer, make regular reports of catches and positioning, and comply with port inspections.

CCAMLR has a prohibition on the use of gillnets and a complete ban on bottom trawling in the high seas of the Convention area and in shallow (550m) water around the Antarctic continent (CCAMLR, 2016). In SPRFMO, conservation measures ban gillnets in the convention area, and seek to minimising the incidental bycatch of seabirds. SPRFMO Conservation Measure 13-2016 details the requirements of an exploratory fishery, including the estimated effects of the proposed activity on associated or dependent species and the measures that will be taken to mitigate these effects. The SPRFMO Scientific Committee

has also identified ecological risk assessments (ERAs) as a way of evaluating the risk of impacts on bycatch species in particular areas, which may need increased monitoring or intervention.

In a 2013 meeting on the Areas Beyond National Jurisdiction (ABNJ) Deep Sea Project, the CCAMLR Scientific Committee mentions the importance of spatial planning and zoning to ensure the sustainability of fishery resources and protection of ecosystems. Identification and mapping of VMEs is a key priority of the SPRFMO Scientific Committee, with recommendations that the Commission implement a spatial management approach to protect VMEs and areas where VMEs are likely to occur, while enabling viable fisheries with a balance of open and closed areas. This spatial management approach is consistent with other RFMOs, including SEAFO and SPRFMO, where move-on rules are a temporary and precautionary measure implemented prior to planned spatial closures to protect VMEs.

In CCAMLR, protection of benthic habitats from the effects of fishing is taken a step further. Growth rates of Antarctic benthic organisms are typically slower than in temperate regions (Peck, 2016), and combined with the lack of information on benthic ecosystems and recent research revealing a highly biodiverse benthic fauna, calls for greater levels of protection and consideration.

In comparison with SEAFO and SPRFMO, CCAMLR is well advanced in implementing spatial management as part of an EBM approach, with proactive protection of vulnerable areas, and a consistent agenda for implementing MPAs for a variety of different objectives. There is still room to improve in this space, consolidating a series of ad hoc spatial measures into a more comprehensive strategy, such as marine spatial planning. Integrating MPA's within an MSP framework creates a network that is much more resilient than a single MPA, by providing buffer areas and allowing species to shift in response to climate change (Katsanevakis et al., 2011).

4.3. Advanced measures of EBM

Moving on, my next themes in the research hierarchy are that of integrated, resilience, and strategic management, moving beyond an EAF to a more fully realised EBM. Table 8 shows the elements of EBM discussed in CCAMLR annual and Scientific Committee meetings and the relevant concepts from 2005 to 2010, with table 9 showing elements discussed from 2011 to 2015. From as early as 2005, wider ecosystem considerations are discussed in CCAMLR meetings, specifically on using reference areas to differentiate the effects of fishing from wider ecosystem change. Climate change impacts relating to the krill fishery are referenced in 2006, and a feedback management scheme proposed in 2007.

Table 8. Elements of EBM discussed in annual CCAMLR and Scientific Committee meetings from 2005 to 2010 for the thematic grouping of the resilience, integrated, and strategic nodes.

Year	Strategic / Resilience / Integrated elements of EBM	EBM concepts
2005	MPA design Ecosystem reference areas Monitoring environmental & human-induced changes	MPAs Wider ecosystem considerations
2006	Potential effects of climate change & advice to the krill fishery	Climate change impacts
2007	Feedback management scheme for climate change ASOC request for the commission to develop a strategic plan for krill fisheries – prioritize critical issues, long-term vision focused on the role of krill in the Antarctic marine ecosystem Climate change impacts to be placed on future agendas Duty to provide responsible policy action on climate change IUCN – CCAMLR should take urgent action to monitor impacts of climate change and incorporate into decision making.	Fisheries management for climate change Long-term planning
2008	Australia - progress development of a feedback management system for krill, with responses to ecosystem changes Climate change impacts an important topic, but little has resulted in CCAMLR in the form of policy or operational change SC & UK - consideration of the potential effects of climate change on invertebrates, higher-trophic levels, CCAMLR managed fisheries, effects of increased accessibility in ice-free areas	Responsive fisheries management Climate change impacts
2009	In meeting obligations for ecosystem-based management of Antarctic fisheries, CCALMR needs to take into account the cumulative impacts of fishing and climate change ASOC - SC to intensify efforts to provide advice to the commission re: establishing MPAs to increase resilience of the ecosystem to cope with climate change, applying further precaution in the setting of catch limits in areas where rapid change is occurring, and improving ecosystem monitoring and management rules Resolution 30/XXVIII implemented on climate change Performance review recommended strategic development of MPAS, that MPAs can be established for different purposes	Fisheries management for climate change MPAs
2010	Value of MPAs as a means to monitor change IUCN - concern about the emerging impacts of global climate change and ocean acidification Reference areas where fishing does not occur may be needed to measure climate change impacts and meet the monitoring requirements for CEMP Ecosystem monitoring within an individual MPA may not help CCAMLR respond to climate change processes alone, nor a system of MPAs if areas are small and climate processes rapid - WG, larger areas may be more resilient, especially if protected from harvesting A system of undisturbed areas could be used to monitor effects of climate change impacts and take account for regional differences	MPAs Climate change impacts

Table 9. Elements of EBM discussed in annual CCAMLR and Scientific Committee meetings from 2011 to 2015 for the thematic grouping of the resilience, integrated, and strategic nodes.

Year	Strategic / Resilience / Integrated elements of EBM	EBM concepts
2011	Use of protected areas as reference areas to study ecosystem effects of harvesting	Effects of fishing on the ecosystem
2012	Strategies available to CCAMLR to increase adaptability and resilience of Antarctic marine ecosystems to climate change Can use food web models to examine changes in the dynamics of components of the ecosystem due to climate change effects High level of emphasis on the precautionary approach if ecosystem processes are driven in an unfavorable direction USA - no fishing zone as part of MPA proposal to study the effects of fishing and climate change on the ecosystem	Ecosystem protection in the face of climate change Precautionary approach MPAs
2013	CCAMLR can take actions to mitigate climate change impacts, and slow cascading environmental effects Climate change impacts should be integrated into CCAMLR decision-making to apply the ecosystem and precautionary approaches	Effects of climate change on the ecosystem Precautionary approach
2014	MPAs a tool to achieve long-term strategic objectives for ecosystem-based management Ecosystem variability and change a challenge for conservation and the Commission MPAs enable long-term protection alongside fisheries management	MPAs Conservation
2015	Australia - invited the Commission to more effectively plan and organize work, including priority-setting exercise Importance of planning the work of the Commission with a strategic focus Attention needed to develop management approaches for a changing climate, including models for decision rules and responsive management strategies	Forward planning Managing for climate change

Consideration of climate change impacts requires forward thinking and an awareness of cumulative impacts on the ecosystem, including those originating outside the fisheries sector. In 2007 the IUCN urged CCAMLR to take action to monitor climate change impacts and incorporate this into their decision making. By 2015, managing for climate change is still being discussed in CCAMLR meetings, notably incorporating information into decision rules and responsive management strategies. Finally, for the integrated and strategic research themes, discussion in 2014 centred on MPAs as a tool to achieve strategic EBM objectives in the long-term, and in 2015, Australia invited CCAMLR to plan and organize work more effectively, and to set priorities. This forward planning, or planning with a strategic focus, is

key to moving from the basic and intermediate levels of EBM through to an advanced vision that is more realised, integrated, and future-focused.

As mentioned in the literature review, there are different levels to the ecosystem approach that vary in complexity. Table 10 shows elements of EBM increasing in complexity from bycatch and precautionary measures to that of more advanced marine spatial planning and systematic conservation planning approaches. Implementation varies among the case studies, with SEAFO and SPRFMO implementing bycatch, precautionary, and VME protection measures, but not yet achieving the more complex spatial management or planning. In contrast, CCAMLR has partial or complete implementation for climate change, marine protected areas, marine spatial planning, and systematic conservation planning. This could be due in part to the success of the CCAMLR Ecosystem Monitoring Program (CEMP), where reference areas are a key tool in distinguishing between the effects of environmental change and the effects of fishing on dependent predators.

Table 10. Elements of an ecosystem approach to fisheries increasing in complexity from bycatch measures to systematic conservation planning as implemented in CCAMLR, SEAFO, and SPRFMO.

Case study	Bycatch	Precautionary	VME Protection	Climate Change	Marine Protected Areas	Marine Spatial Planning	Systematic Conservation Planning
CCAMLR	Yes	Yes	Yes	Partial	Yes	Partial	Partial
SEAFO	Yes	Yes	Yes	No	No	No	No
SPRFMO	Yes	Yes	Yes	No	No	No	No

CCAMLR has a much greater commitment to spatial management, going beyond the protection of vulnerable marine ecosystems seen in SEAFO and SPRFMO. Given the similarity in the mandates of the different organisations, could there be a difference in how the convention texts have been interpreted, and therefore implemented? Or is there less pressure on SEAFO and SPRFMO from a conservation perspective? CCAMLR and the management of Southern Ocean fisheries garners more media attention and public scrutiny, presumably because of the interest in Antarctica and the perception of the ocean surrounding it as an untouched oasis, and one of the last pristine environments in the word. There could be more urgency to protection, and a greater understanding of the importance of Antarctic marine ecosystems for regulatory functions. Indeed, it is noted in the preamble to the CAMLR convention text that there is some urgency to conservation. This is consistent with the rationale for

establishing the Convention, which was to protect the krill-based ecosystem from an emerging fishery for krill. Nearly forty years later, conservation of Antarctic ecosystems is both urgent and important.

From my document analysis, it is clear that CCAMLR is a leader in marine spatial protection. This could be due to the conservation principles of Article II, which clearly set out an approach to harvesting that prevents irreversible changes to the ecosystem and prioritises the maintenance of ecological relationships. Neither the SEAFO nor SPRFMO convention has provisions for the maintenance of relationships between harvested and dependent species. Essentially, this is the core of an EBM approach, taking into consideration the interconnectedness of species in a systems-oriented view. Minimizing harmful impacts on dependent species is key to EBM. But as a concept, more is needed for it to be fully realised.

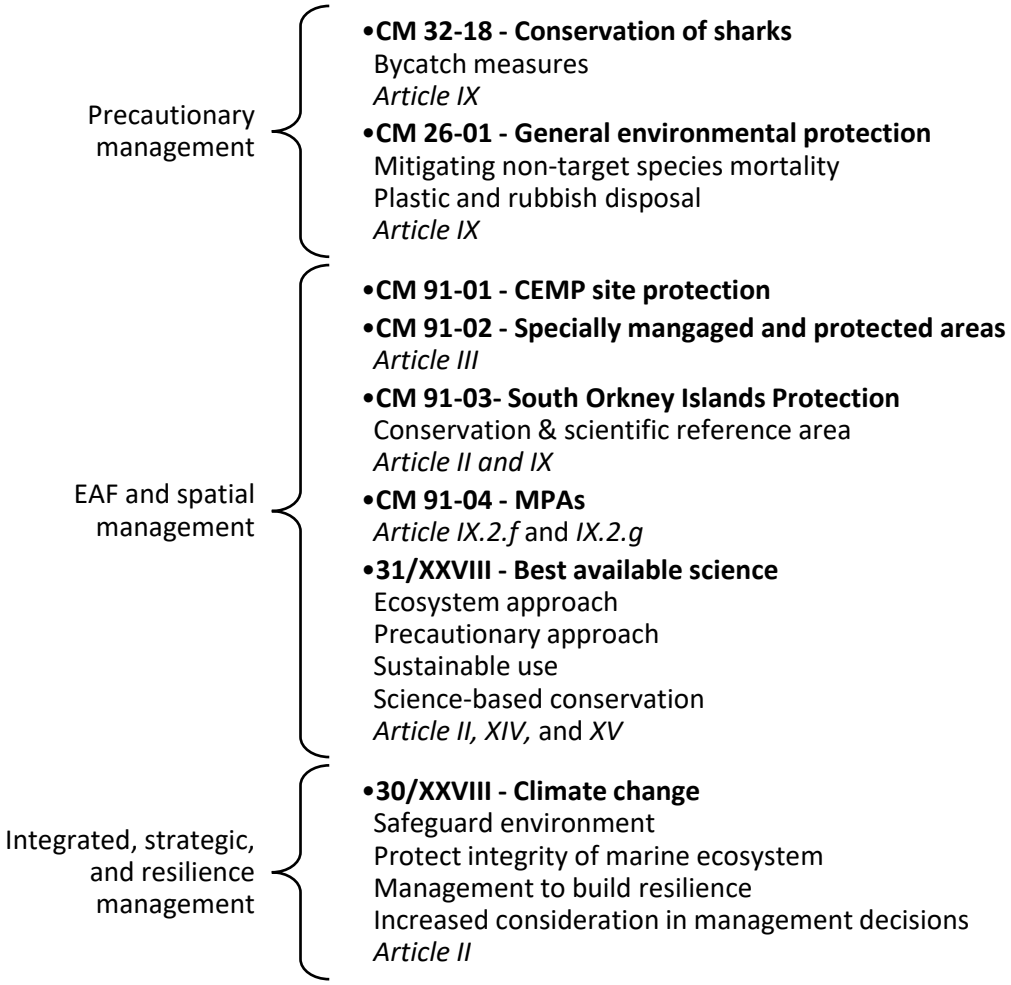

Figure 8. CCAMLR conservation measures and resolutions selected for the document analysis grouped according to EBM research theme hierarchy.

Implementation of the basic elements of EBM are evident in conservation measures of the different organisations, and have been detailed for bycatch and spatial protection in SEAFO, SPRFMO, and CCAMLR. Figure 8 shows the conservation measures and resolutions and resolutions selected for my document analysis grouped according to research themes, starting from the basic current management, through to the intermediate EBM and spatial, and then on to the more advanced integrated, strategic, and resilience. Bycatch measures for the conservation of sharks and general environmental protection conservation measures sit in the current management theme. Conservation measures for site protection for environmental monitoring, MPAs, and best available science are positioned in the intermediate research themes. However, the only measure in the integrated space so far is the resolution on climate change, which is non-binding to CCAMLR members.

The preamble to resolution 30/XXVIII on climate change notes that management action can help build resilience and protect the environment against the impacts of climate change, thereby ensuring the continued conservation and rational use of resources. It urges increased considerations of the impacts of climate change to better inform management decisions. Ultimately, it is a statement of intent, rather than a plan of action. What is needed is something more definitive, that sets out how CCAMLR is going to achieve an integration of climate change considerations into management decisions. This could take the form of a feedback management approach such as the approach proposed for the krill fishery, for example. A resolution outlining the challenge posed to CCAMLR by climate change is insufficient, and CCAMLR must do more in this space if it is to move forward and develop the ecosystem approach to management for which it is known. A conservation measure, similar to the 2011 measure adopted for the establishment of MPAs, could help to clarify and prioritise work needed to move beyond discussion of the impacts of climate change to actual implementation of policy to manage fisheries in light of current and potential changes to the ecosystem. It has been seven years since the climate change resolution was adopted in 2009. A conservation measure on the CCAMLR approach to climate change by 2019 would be a key milestone in developing the precautionary approach, and once again would position CCAMLR as an organisation committed to achieving its key conservation objectives.

Finally, in Figure 9, CCAMLR and the case studies are positioned in relation to the research theme hierarchy, conceptualising the overall findings of my document analysis and literature review. SEAFO and SPRFMO are placed between the precautionary and EAF themes, indicating that they are moving towards an EAF, but not yet at the same level of implementation as CCAMLR. Likewise, CCAMLR is well placed in regard to implementing an EAF and spatial management, but development is needed to create

a spatial approach to management that more comprehensive. The next steps for CCAMLR are in the advanced measures of EBM, by creating an EAF that is future-focused and committed to the EBM principles of integration and resilience across the social, ecological, and management dimensions.

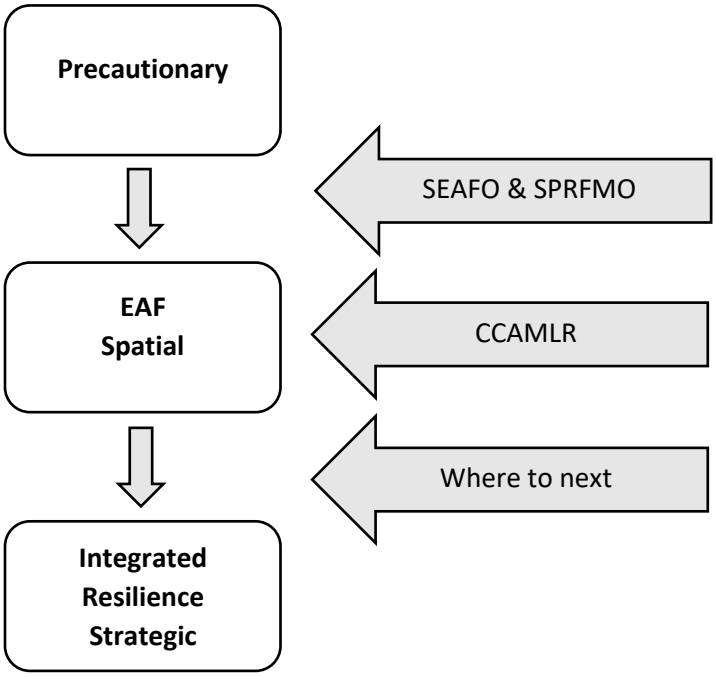

Figure 9. Research theme hierarchy showing the position of the case studies SEAFO, SPRFMO, CCAMLR, and where to next.

In this chapter, elements of EBM were explored through the development of a research theme hierarchy. The discussion moved from basic measures of a precautionary approach and the EAF, through to spatial management, and then measures that take into consideration climate change and the resilience of marine ecosystems. To conclude the research, in the next chapter emerging themes from the document analysis will be explored from the document analysis and literature review.

5. Conclusion

EBM as articulated within an EAF constitutes an integrated approach to managing human activities in the marine space. But determining the boundaries between the two approaches is a complicated endeavour, requiring a solid understanding of the definitions and principles of EBM, and the scope and responsibilities of an EAF. For managers of marine resources, understanding what exactly is meant by an EBM approach is necessary in order to move forward with implementation. The aim of my research was to examine the implementation of EBM in CCAMLR by comparing this with the level of implementation achieved in SEAFO and SPRFMO. I hoped to get an understanding of where the CCAMLR EAF was placed on a spectrum of EBM, or a hierarchy of different levels of implementation. Through my document analysis, I found that CCAMLR was a leader in some aspects of EBM, notably precautionary and spatial management as part of an EAF, but lacking in other aspects, such as integrated management.

5.1 Emerging themes

Integration was one of the key themes that emerged from the document analysis and literature review. It is used to define EBM, is one of the key principles of EBM, and can be used as a way of conceptualizing what EBM seeks to achieve – the bringing together of separate parts of a system, to be considered as part of a whole. Decisions are therefore based on a broader view of the management context, and the component parts of the issue to be managed.

Another emerging theme is of the distinction between EBM and EAF as being crucial to understanding what an EAF is, and also, what it is not, and what it can't achieve. The two terms cannot be used interchangeably, though they often are, leading to confusion and a misguided understanding of what is needed to successfully implement an EBM approach. An EAF is not the same as a comprehensive EBM approach, and ostensibly, can never be the same due to the boundaries of the fisheries sector. Fisheries management organisations such as CCAMLR, and RFMO's can only do so much, with van Hoof (2015) questioning whether an all-encompassing EBM approach would be too much for a single regional forum to handle. This could also be a critique and possible limitation of my research. Perhaps CCAMLR does not need, or is not able, to manage an EBM approach covering activities and impacts across the entire Southern Ocean. But the literature on the efficacy of EBM is irrefutable. EBM is the way of the future, and just as the EAF evolved out of traditional fisheries management, so too should an EAF progress towards EBM to meet the challenges facing the marine environment and resource management. Although the mandates of RFMO's do not allow for the consideration of impacts of different sectors

(UNEP, 2016), CCAMLR is by definition not an RFMO, and has always had a broader ecosystem-oriented mandate. This was evident when comparing CCAMLR's success implementing a broader suite of EBM measures in comparison with the two RFMO case studies, and especially in relation to climate change. In essence, climate change is not associated with harvesting activities, is not an impact of the fishing sector, and is not mentioned in the CAMLR Convention text. But from an EBM perspective, considering the effects of climate change on ecosystems is crucial to be able to properly inform decision making regarding the management of a fishery. Therefore, CCAMLR is well placed to pioneer a move towards comprehensive and potentially even cross-sectoral EBM, as it is nestled within the Antarctic Treaty System, and has a greater responsibility and added incentive through the Protocol on Environmental Protection to the Antarctic Treaty to protect the environment (Miller & Slicer, 2014).

5.2 Final thoughts

Fishing and conservation can, and should, co-exist. One pathway to co-existence is to commit to developing a fully realised EBM approach from existing EAF mandates. CCAMLR is uniquely placed to champion this transition, with a strong conservation-orientated Convention text, a history of implementation of EBM measures, and connections to an overarching environmental protection regime in the Protocol on Environmental Protection to the Antarctic Treaty. But in order to advance the EAF in the Southern Ocean, action on climate change must be taken, and a more comprehensive approach to spatial management introduced. Ultimately, the challenge of implementation in CCAMLR is to narrow the gap between key principles outlined in the literature, and what is actually being implemented. It is important to have a clear definition of terms and approaches moving forward, to guide implementation and avoid any confusion in the application of an EBM approach. At its core, EBM is an integrated strategy to the management of marine resources, and fostering a sense of integration and developing more of a strategy is needed in implementing EBM in the Southern Ocean.

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